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Challenges and pitfalls in brownfield EPC projects

Job requirements and scope are well defined in engineering, procurement and construction (EPC) contracts because they are designed and engineered from scratch. Owners prefer to get work done through EPC contracts as it helps them in obtaining a firm cost and time commitment.

Executing a brownfield project in a process plant presents many challenges and complexities due to unknowns and potential variations. Major factors include the non-availability of old data drawings, design calculations and updated/as-built drawings.

Normally, small brownfield projects are preferred on a cost-plus basis, as engineering and execution go side by side and uncertainties are identified as the job progresses.

Considering the advantages of an EPC contract, owners usually prefer to pair brownfield work with any upcoming greenfield expansion projects. This makes the project attractive to an EPC contractor, and the owner can also get firm cost and schedule commitments. Time issues becomes more complex when more than one or two EPC contracts are awarded in the same or adjoining field, sharing some common facilities, space and working areas. In such cases, the interdependency of the two contractors also increases.

Some of the challenges and lessons learned while executing such hybrid projects are presented here. Although these issues may appear to be standard, they can have serious consequences if not considered during a cost estimation. Normally under such contracts, the owner and its team (or PMC) earnestly intend to provide all details at the enquiry stage. However, they try to cover any out-of-sight discrepancies by using a typical clause:

> "Details provided in the inquiry document are the best possible at the time of release of this document. However, these are subject to field verification by the contractor prior to submission of bids. Unless any exceptions or deviations are put forward by the contractor and accepted by the owner, any subsequent changes later shall not be acceptable, and time and cost implications shall be to the contractor's account."

Some common types of design and execution challenges are detailed here.

Process area. Process conditions at the battery limits of any operating plant are dynamic and expected to have variations that must be detailed in the inquiry for the contractor to conduct a hydraulic check. In a project, due to this omission, one acid gas collection required an increased stainless-steel header size at a late stage; as available gas came to it from different units, the pressure was insufficient to reach to the downstream sulfur recovery unit (SRU).

In an integrated analysis of a complementary brownfield with greenfield project, complete hydraulics and pressure balancing is required for systems like air, cooling water, steam, flare, etc. In another project, a problem was encountered with cooling water supply pressure and quantity, resulting in the augmentation of the old plant cooling water system.

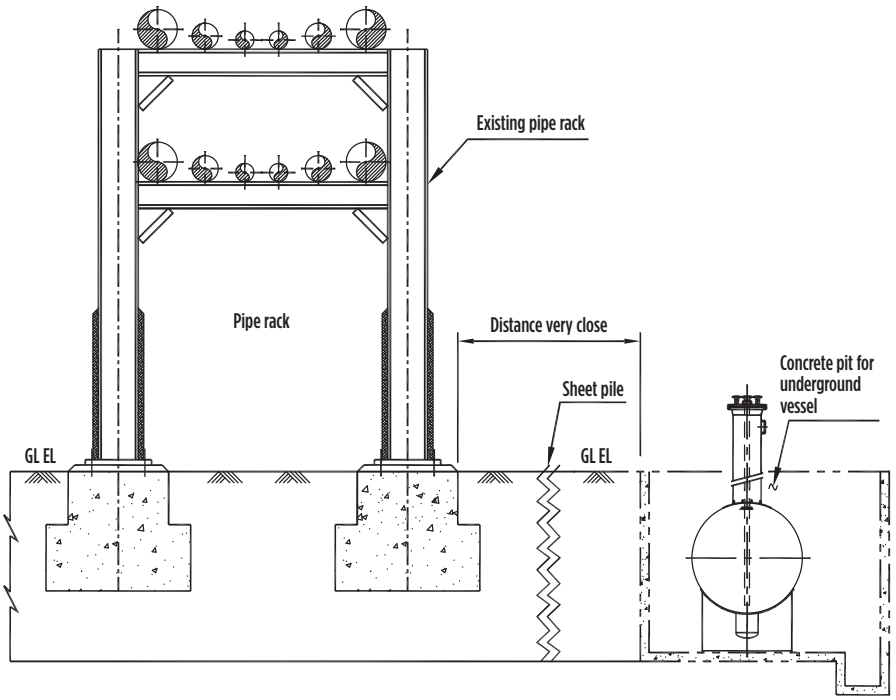

FIG. 1. During excavation, sheet piling was used to protect the foundation of a pipe rack.

Metallurgical improvements occur regularly in the process industries. The extent of implementation of superior metallurgy in brownfield modifications should be demarcated clearly along with the greenfield project. The construction material of piping, instrumentation and equipment internals, etc., should be clearly marked on a material selection guide (MSG) and material selection diagram (MSD) to avoid the confusion of a superior metallurgy change in the old units.

Demolition and cleanup of any old unit. Demolition of an old unit and site clean-up to create space for a new unit is normally part of any project. The scope normally covers the removal and disposal of old equipment, piping, foundations and structure in a safe manner.

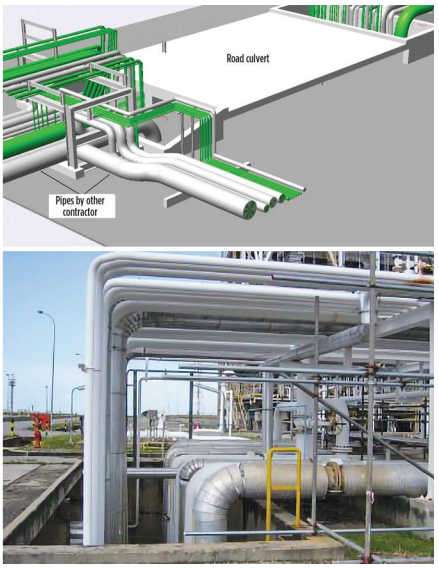

FIG. 2. A new culvert was designed to carry pipes of two EPC contractors.

The area should be inspected for hidden surprises, such as underground cables, pipes, drains or any process lines and old foundations. The area should be thoroughly scanned by suitable tools (ultrasonic or other type) to avoid damage to any live system.

Any adjoining building or structure that is live and may get impacted during excavation work should be identified and an accordingly suitable reinforcement of structure must be planned.

Excavation work near existing building/structure. Soil condition, depth and angle coverage of excavation, and distance from any existing structure or pipe rack should be ascertained before proceeding with excavation.

In one project, the soil condition was found to be very unstable. Excavation was required for the construction of a concrete pit to stall an underground slop tank. Excavating close to the existing pipe rack could have damaged its stability.

The project personnel had to either shift the location of the pit or use sheet piling, as shown in FIG. 1, to protect the foundation of the pipe rack. Shifting the location was not possible without major engineering changes, so the second option of sheet piling was used.

Mechanical functional area. Front-end engineering design (FEED) should normally cover all relevant data, drawings and health check reports of existing equipment (where modifications and alterations are planned).

Similarly, an equipment health check on equipment, the foundations size and depth, current condition and preferably the old design calculations should also be available.

Any change in old equipment loading data due to change of internals will have an impact on the foundation. Significant changes can occur in equipment design conditions, design codes, stress values, wind and seismic conditions, etc.

Another project faced a height increase requirement of a distillation tower to accommodate an extra packed bed in the top section. Because an increase in the column height in the top section was needed, the column design required a complete review based on the latest codes, standards and new design conditions. However, the old foundation details and design calculations were unavailable, and it was challenging to carry out a health assessment of the old foundation and justify its adequacy.

Similarly, stress relieving and hydrotesting of an old column after modification are other important issues, considering the need to safely hold the tower during heat treatment to check the suitability of an old foundation for hydro test load.

Civil and structural area. When modifying or retrofitting any existing technology structure, pipe racks, road bridges, and where process equipment, agitators, etc., are added, an evaluation is required for all static and dynamic loads, along with their foundations as per the latest rules, design codes and regulations.

Piping functional areas. Tie-in points locations and accurate piping end connection details are vital. In a project, the line/flange size of one tie-in could not be ascertained, as it was at a high elevation and unapproachable. The information provided by the operators was relied upon. However, during execution, the pipe size was found to be different; this resulted in a last-minute rush for design changes, approvals and material procurement. Pipe metallurgy, size, flange facing and rating, type of gasket and provisions for piping isolation valves must be carefully checked for each tie-in.

Isolation valves are normally the

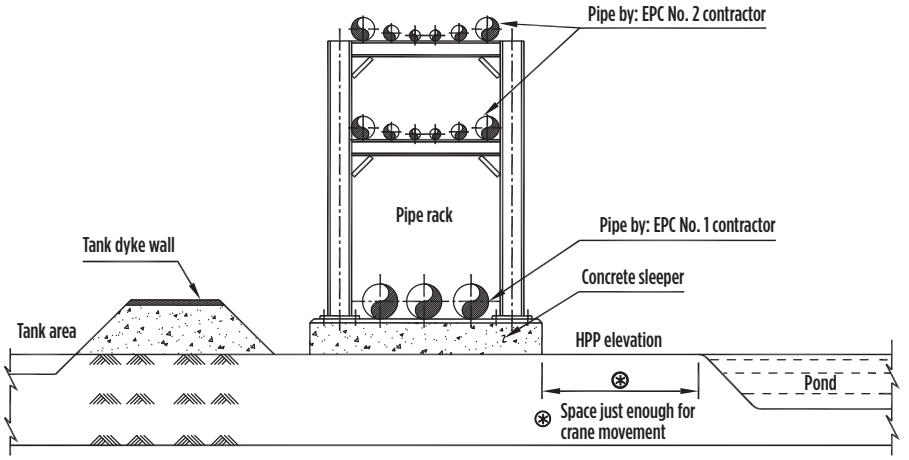

FIG. 3. To allow two contractors to carry out piping work between a tank dike wall and a pond, with little space for vehicular/crane movement, a goal post-type frame was mounted on concrete sleepers.

preferred choice as they do not require upstream shutdown. However, the operability of these isolation valves must be checked, and they must be kept in proper serviced condition.

All tie-in points must be tagged with tag numbers (the preferred method is to have non-metallic plates with painted or embossed numbers). A location coordinate table of all tie-ins should be marked in piping layout drawings.

A unique problem of different material specifications of PMS between two EPC contractors at tie-in points has been encountered—this difference is difficult to justify to an owner.

Piping corridors. The author has encountered the sharing of available space in existing pipe bridges racks, road culverts and pipe ways with another contractor. FIG. 2 shows where a new culvert was designed to carry pipes of two EPC contractors. The design was complicated due to a "T" joint and a side-by-side passage through a road crossing. This required many joint sittings of the two contractors with the PMC. An agreement was required to determine the roles and division of work within the culvert area between the two contractors, in addition to the issue of material supply, to avoid clashes between the two teams.

Similarly, in another case, a very narrow space was available for two contractors carrying out piping work between a tank dike wall and a pond, and with little space for vehicular/crane movement (FIG. 3).

One contractor's scope was to lay large trunk pipelines on a concrete sleeper, while the other contractor had too many smaller pipes on a "T" post or pipe rack, running parallel as per the original contract. The original design eliminated space for crane or vehicle movement. Both contractors agreed to a common type of supports. A goal post-type frame mounted on concrete sleepers (FIG. 3) proved to be a win-win solution.

Instrumentation. This can be the most troublesome part in any brownfield project if it is not properly conceived by the owner and clearly explained to the EPC contractor.

Technological advancements are continuously emerging on types of instrumentation, communication, EMC and RFI feature compliance.

If the previous plant control room was an older generation, then the owner must ensure that changes and revisions are duly implemented and the compatibility of field instruments with the control room is addressed.

Upgrading software is required as part of control system integration of instrumentation, as well as cybersecurity and confidentiality requirements.

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